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1953



SORTING COFFEE BERRIES
IN GUATEMALA

Foreign Agriculture

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FRONT COVER

Sorting Coffee Berries in Guatemala

The coffee harvest is an important one not only to Guatemala and many other countries of Latin America but to the United States as well: It yields returns that run into billions of dollars, and from it come the countless pounds of coffee used in this country every year.

BACK COVER

World Coffee Mission

To protect Latin America's coffee plantations against attack by the devastating Hemileia rust, Point Four recently sent two United States Department of Agriculture technicians on a 36,000-mile round-the-world trip to find coffee varieties resistant to the disease.

Credit for photos is given as follows: pp. 48, 50, 52, Dr. F. L. Wellman; pp. 56, 57, Earle K. Rambo.

NEWS NOTES

Wilcox New OFAR Head

F. R. Wilcox of San Marino, Calif., was designated acting director of the Office of Foreign Agricultural Relations on February 25. He succeeds John J. Haggerty, who is returning to agricultural work in the Foreign Service. Mr. Wilcox has accepted the assignment on a temporary basis.

Mr. Wilcox, who is assistant general manager and treasurer of Sunkist Growers (a citrus cooperative marketing organization formerly known as the California Fruit Growers Exchange), has been active in private, cooperative, State, and Federal agricultural work for many years. He is a member of the Department of Agriculture's National Citrus Advisory Committee and a director of the Central Bank for Cooperatives.

Mr. Wilcox has been with the citrus marketing organization since 1939 when he became treasurer of the organization. He has been assistant general manager since 1941.

He was graduated from the Utah Agricultural College in 1925 and attended the University of California from 1925 to 1927.

He was in research and agricultural extension work at the University of California from 1927 to 1929, and after that he served as general manager of the National Pecan Marketing Association at Jackson, Miss., from 1929 to 1930, and as general manager of the United Prune Growers at San Francisco from 1930 to 1931.

FOREIGN AGRICULTURE

ALICE FRAY NELSON, EDITOR

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The Americas Face Up to Threat of Coffee Rust

by FREDERICK L. WELLMAN



Americans produce and drink the best coffee in the world, which comes from the plant *Coffea arabica*. But wherever this plant grows, it is under constant threat from a destructive disease, a rust known as *Hemileia vastatrix*. Already this disease has devastated Arabica plantations all through Africa and the Orient, forcing growers either to plant an inferior but sturdier coffee or to abandon coffee entirely. Thus far the rust has not invaded the Western Hemisphere; but, if it should come in and do the same damage here as elsewhere, a \$2½ billion industry would be undermined and the whole economy of a dozen Latin American countries would be shaken.

Rather than wait for disaster to strike, coffee specialists working in Latin America have long been advising aggressive action. Recently the problem has been more urgently considered, and in the spring of 1952 it engaged the attention of the Technical Coöperation Administration, which, through the Institute of Inter-American Affairs, administers the Point Four program in Latin America; and these two agencies decided to send two coffee specialists on a world trip to study the coffee rust disease at first hand and to find what could be done to fortify this Hemisphere against it.

They summoned two coffee researchers from their work in Latin America—Dr. William H. Cowgill¹ and me. By the last of June all the arrangements had been made and our itinerary planned, and we were leaving New York on a trip that was to take us 36,000 miles by plane, jeep, boat, and foot to the coffee plantations of a dozen countries in the Eastern Hemisphere.

Generally, we hoped to find ways of fighting *Hemileia* in Latin America. More specifically, we hoped to study the rust in action and observe its behavior under a variety of conditions; to note how

Oriental coffee growers had learned to live with the disease and adjust to its ways; to establish contacts with coffee scientists and institutions so that technical collaboration would be strengthened between East and West in combating a common problem; and to acquire plant materials, especially seeds of any coffee varieties we might find with marked signs of resistance to the disease.

Before we left, we knew that two species of rust had been described: *Hemileia vastatrix*, the long-known classic rust that has caused widespread devastation; and *Hemileia coffeicola*, which was described only 20 years ago and which, for some unknown reason, has never spread outside the French Cameroons and the Portuguese island of Sao Tomé. The second one, which we finally were able to study in some detail in the French Cameroons, also is a threat to the world's coffee plantations. Much needs to be known about it, especially the extent to which it can be controlled by disease-resistant plants. We did see that it had been brought under adequate control by spraying. In the discussion that follows, however, I refer only to the old *Hemileia*, which we had set out to study.

We began our mission by visiting colonial offices in Europe, where much of the research in tropical agriculture had its beginning and whence support and encouragement for that research has continued to flow. There—in London, Amsterdam, Brussels, Paris, and Lisbon—and in the offices of the Food and Agriculture Organization in Rome, we met men who had worked with coffee in India, Indonesia, the Belgian Congo, French Cameroons, Angola, and other colonial areas of the Tropics, and who knew the story of the long struggle against rust.

For it has been a long struggle, on an ever-widening front. Existence of *Hemileia* rust was first noted by a British explorer back in 1861, near Lake Victoria in Africa. Eight years later it put in

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its appearance in Ceylon, and from there it spread through the East with frightening speed. It leaped to southern India, to Sumatra, then to Java, Fiji, Natal, Mauritius, and Réunion. It moved unchecked to Madagascar and China, was in the Philippines by 1890, and in Samoa shortly afterward. In 1903 it came to Puerto Rico, but there the diseased plants were promptly destroyed and the rust was checked before it had a chance to make a beginning. In 1910 it appeared in New Caledonia. As recently as 7 years ago it showed up in Zanzibar, giving warning that it was still on the march. All in all it has ravaged coffee plantations in 32 countries of Africa, Asia, and Australasia. In agricultural history it is considered as one of the Seven Great Plagues.

Hemileia vastatrix attacks coffee trees of all ages. Most serious effects come during seasons when light rains alternate with short periods of good weather; and they are even worse when night dews are heavy. Ideal temperature for the rust is about 75°F.

First symptoms are small light yellow spots on the underside of the leaves. These spots, which have an oily translucence, enlarge and darken within a few days, perhaps spreading to a diameter of nearly an inch. As they grow older, they turn bright orange, taking their color from a powdery coating made up of multitudes of spores produced 9 to 17 days after the spots have appeared.

Soon the spots begin to show through on the upper surface of the leaves, and the tissues die. Diseased leaves drop readily; many a branch is left with only two or three pairs of terminal leaves. Trees become more and more weakened and stunted, and are made especially susceptible to branch dieback. Trees so affected cannot do more than exist.

Spores of the fungus are borne on clusters of delicate threads, from which they are readily detached by the wind and thus are freed to float out into the air. The spores are tough, well able to live for six or more months in a dry condition. They can be carried between widely separated places in countless ways—in air currents stirred up by tropical storms, on people's clothing, on insects, on wrapping and packing materials, and inside and outside all kinds of shipments.

When moisture and temperature are suitable for development of the spores, they germinate in 2 to 3 hours and, in doing so, produce infection hyphae.

Young coffee leaves are most susceptible to penetration by these hyphae; but older leaves, too, are vulnerable. About 2 weeks after infection, the pale yellow spots appear on the leaves and the damage has begun.

Even worse than the swiftness of the rust's spreading is its destructiveness. It has forced Ceylon, once the greatest coffee-producing country in the world, to give up its coffee plantations and turn to producing tea. In only 4 years after entering the country, the disease had infected millions of trees; and in 10 years Ceylon was counting its annual losses from the disease at 2 million pounds sterling. At the country's agricultural experiment station, I saw a poster showing pictures of rust-ravaged coffee, with the statement, "This is the disease that cost Ceylon



Hemileia rust defoliates coffee trees and kills them in 2 or 3 years. Leaves on this tree in the French Cameroons have only recently become spotted with the rust and some have already fallen.

£14,000,000." And that was an old poster, which referred to the time when an English pound was based on the gold standard!

In some of Malaya and parts of India, coffee growing has been almost completely abandoned because of rust. In the Philippines the coffee crop was reported reduced by 35 percent shortly after the disease had entered. In New Caledonia it took only 2 years before planters were losing half of their crops; and in Java the usual 60,000-ton crops were quickly cut by two-thirds. These are only a few examples and were just the beginnings, because losses intensified as time went on.

Thus it was that the centers of Arabica production shifted, slipping along the Equatorial Belt to the other side of the world. At first, countries in the American Tropics grew coffee only as an experimental crop; but now they have an estimated 5 billion Arabica trees and supply nearly nine-tenths of the world demand. They sell so much coffee to the United States that coffee has become that country's No. 1 import as far as value goes and is the strongest commercial link between the two areas.

That Hemileia rust has not yet invaded the fruitful coffee plantations in the Americas is a source of wonder. True, Americans have long been aware of the danger. In the past 60 years there have been at least 19 published warnings of the possibility of invasion. Many Latin American countries have stringent laws to control the introduction of live coffee plants; and countries without such laws have a firm restraint in the form of public opinion. Isolation has been a factor, too: until recent years slow transportation has prevented much long-distance transfer of live plants. Besides, for a long time no one has felt much need to introduce coffee trees, except for botanical gardens and as curiosities.

Even so, luck and the accidents of circumstance must explain a good deal of the freedom from rust that we have enjoyed thus far.

But luck cannot be depended upon forever. And conditions are changing. Airplane traffic is general and increasing. Today's economies and methods require a better coffee tree than any we have now; and to develop such a tree we will have to bring in different varieties from Africa and the Orient. In the next 20 years the danger of introducing coffee rust into the Americas will be multiplied many times. No matter what we do, the disease will prob-

ably come to us at last. And, when it does, we must somehow be ready for it and able to avoid the destructive effects it has had elsewhere.

No one could be more aware of the threat facing American coffee planters than the scientists and planters in the East, who have seen plantation after plantation succumb to the scourge. Wherever our trip took us, whether to colonial and international offices in Europe or to the plantations and experiment stations in Africa and Asia, we met nothing but sympathetic concern for our predicament and an eagerness to help us keep our security against rust destruction. Looking back at the 5 months we spent in seeking that security, we are heartened by the hope that lies in what we have seen and learned and carried home.

We visited coffee plantations in 13 countries—French Cameroons, Angola, Belgian Congo, Ruanda-Urundi, Uganda, Tanganyika, Kenya, India, Ceylon, Malaya, Java, the Philippines, and Hawaii. In most of these countries many growers have given up trying to raise the fine-flavored but rust-susceptible Arabica coffees and have replaced them with either the species *Canephora*, called Robusta, or *Dewevrei*, called Liberica and Excelsa. These replacements are inferior in flavor but easier to grow and, on the whole, highly tolerant to rust. In rust-ridden countries where they still grow Arabica they do so under great difficulty.

In the face of this general trend away from Arabica one country presents an interesting exception: in Ruanda-Urundi the native growers are so determined to produce nothing but the high-quality Arabica, rust notwithstanding, that they have made it impossible for Robusta or other coffees to be introduced.

Two of the countries had no rust.

In Angola, no matter how closely we looked, we found no evidence of the disease although it was present in nearby territory; what is more, I have seen no published reports of its ever having occurred there, and no pathologist whom I talked with and who had worked in the area or in Portugal had ever seen it. Even in Angola, however, Robusta is being grown, just as is Arabica. In this case, Robusta has been planted simply because it has finally become acceptable to coffee drinkers in Europe. And, after all, Robusta is a highly vigorous tree that produces excellent crops under conditions ordinarily considered adverse to high production of Arabica.



This coffee, spread out to dry at a collection center in Angola, is Robusta, which, though less flavorful than Arabica, is sturdier and easier to grow.

Hawaii, too, by some good fortune has thus far escaped attack by *Hemileia*.

The obvious answer to *Hemileia* is to breed new strains of coffee that will combine the fine flavor of Arabica with adequate resistance to the disease. Such breeding work has been carried on for some decades in several countries. But plant breeding takes time, especially if it deals with trees. Not only that, but wars and other pressures have forced reduction in research staffs, particularly when they are engaged with improving a luxury such as coffee. Scientific effort has been needed for more basic crops, such as those that prevent starvation—

mandioc, mealies, beans, and rice.

All through our travels, however, we kept watching for resistant strains of Arabica; and, wherever we found them, we either obtained seeds or secured promises that, after seeds ripened, they would be sent to us. These promises have since been honored.

In south India, particularly, our search was well rewarded. There, at India's Coffee Research Station at Balehonnur, Mysore State, they have been selecting and crossbreeding coffees for more than 30 years, working to combine resistance to rust with high quality of coffee. They have crossed Arabica with *Canephora* plants, and Arabica with *Dewevrei*.

Then, after getting hybrids that are definitely resistant to rust, they have crossed these back with Arabica only. They have selected, from varied populations of Arabica coffees, types showing high resistance. Recently, plant materials secured as a result of all this selection and breeding have been released to several Indian growers for increase, and a small start has been made toward commercial production.

However, let us not deceive ourselves: much still has to be done. In India, where the Hemileia resistance problem has been given fruitful and effective attention, workers have found a complicating factor: Hemileia, like many another rust, has biologic or physiologic races. This fact, which helps to explain the changes in power to attack that the rust has exhibited at uncertain intervals, means that pathologists and geneticists must be forever on guard. They have a perpetual challenge to keep their advances ahead of the natural development of the rust organism as it operates on the coffee crop.

Indian Government officials have assured us that they will cooperate fully with us in introducing these rust-resistant trees into the Western Hemisphere, and already they have shipped seeds to Washington, D. C. These seeds will be propagated in quarantine in the introduction garden of the United States Department of Agriculture at Glenn Dale, Md.; and, when it is absolutely certain that the seedlings are not tainted with Hemileia, most of them will be sent to cooperating agricultural experiment stations in Brazil, Colombia, Costa Rica, and Puerto Rico for planting in test plots. From these countries they will be distributed as rapidly as possible. A large number of these plants are already growing and will soon be shipped to the American Tropics.

If seedlings from the Indian hybrids do well in this Hemisphere, as soon as practical a concerted effort will be made to propagate enough trees to supply new plantings and to reenforce old ones. After that, it will take about 5 years to get them into fairly large commercial production.

But seeds from Indian hybrids were not the only plant materials we obtained. By the end of our trip we had collected seeds and plants of approximately 100 different varieties of coffee that have never been grown in the Western Hemisphere. Some of these coffees thrive in sand; others grow along river banks, with their roots in water. Some have

a distinctly deciduous character to withstand excessive drought, and some produce excellent crops at unusually high altitudes. Some have very small leaves and some are almost like berry bushes in vegetative character. The variations are enormous. All these, too, will be grown under quarantine at Glenn Dale and eventually will be distributed to workers in cooperating experiment stations in Latin America.

These different kinds of coffee will make it possible to broaden immensely the genetic background of coffees grown in Latin America. At present this background is extremely narrow. As far as anyone knows, all the coffee trees now growing in the Americas are the offspring of one Arabica plant—or, at most, only a few Arabica plants—sent from Africa to a greenhouse in France early in the 1700's. The new introductions will offer innumerable opportunities to American plant breeders who are working to develop better coffee trees, trees that are both more productive and more resistant to many diseases and to drought as well as to excessive moisture and high altitude. Whatever happens I feel that it will put in the hands of Latin American plant breeders the genetic make-up from which to produce any number of suitable coffee varieties resistant to Hemileia rust.

Of course the development of rust-resistant coffees, though recognized as the only satisfying solution to the problem, leads down a long and arduous road. In those parts of the East where coffee is still being grown in quantity, pathologists have had to look for a quicker way to arrest the disease, some temporary control or stopgap. If they had not done so, all coffee-growing countries in the Eastern Hemisphere would have been doomed to the same fate as Ceylon, Java, and Malaya.

They turned to the most obvious measure—spraying. Bordeaux mixture is the spray in most common use, in a 1-percent standard solution applied at the rate of 150 gallons to the acre. Other proprietary copper sprays are now becoming more popular.

Spraying, however, is never a fully satisfactory method of controlling plant disease. At best it is expensive, unpleasant to use, and only temporary in its effect. Moreover, effective spraying procedure often demands that the trees be trimmed to make room for the equipment and workers; and such pruning reduces production a great deal, perhaps

by as much as two-thirds in many instances.

And in the Americas spraying is likely to prove less rewarding than in the East. We reached that disquieting conclusion after we had seen that spraying was most successful in British East Africa and parts of southern India, areas with quite different moisture conditions from those that prevail in much of the coffee-producing lands of the Western Hemisphere. In Africa the rains come and go with the monsoons, in sharply defined seasons: the wet, from December to May, and the dry, from June to November. As a result, it is possible to study the spore load of the atmosphere during the dry season and the changes wrought by rains, and thus determine the right time to spray.

This matter of timing has proved to be of the utmost importance. A spray applied in the proper time just after the "long rains" have let up and the coffee trees have finished their most vigorous growth

will protect most of the foliage well into the dry season; a second spray, applied at the proper time in the last half of the dry season, will give protection until the "long rains" begin again. To miss times of application by a week or two may spell the difference between a good crop and a failure.

In the American Tropics, however, wet and dry seasons are not so sharply differentiated. There, two sprays a year would accomplish nothing. Instead, with rains as frequent and intermittent as they are, in some places two sprays a week would be required. And, with the high cost of labor in the Americas, the price of coffee would go up to \$3 a pound!

But exorbitant prices need not be set on American coffee. In the Americas we have the tremendous advantage of a time of respite; and, if we assiduously use it to breed fine new coffees that will stand up against rust, the knowledge and materials we brought back will prove rich prizes indeed.



Spraying coffee trees in southern India to control *Hemileia* rust. Spraying is practical in the East, where plantations are located on gentle slopes and where wet and dry seasons are sharply defined.

Egypt's New Land Reform Program

—A Résumé of the Law

Prime Minister Naguib of Egypt, on September 9, 1952, released the following announcement: "The Council of Ministers has approved tonight a decree law on the agrarian reform and the relationships of land ownership. This concludes the scheme which the people regard as the first step toward rebuilding [Egypt's] economic and social structure."

The agrarian reform thus announced is only part of a broad reform and development program, on which the new Government of Egypt has embarked. But it is a highly important part, for most Egyptians are farmers, three-fourths of these farmers are tenants, and 95 percent of those who do own land have 5 acres of land or less.

The outstanding fact of Egyptian economy is the inadequacy of its arable acreage. Egypt is four times the size of the State of Oregon but less than 3 percent of its land—6 million acres—is cultivated; the rest is desert. About 5 million peasant families make their living on the 6 million acres of land. By way of contrast, in the United States, some 6 million families farm about 360 million acres of land—60 times as much cropland but only about 1 million more farm families. For years, farm population in Egypt has grown faster than land has been reclaimed, and there have been no jobs in industry for this excess population. Land reclamation and industrial development, long recognized as pressing needs in Egypt, are major concerns of the new government.

Its land redistribution will not take place until September of this year, but a brief review of the law may be of interest at this time.

Expropriation

The law sets a 200-feddan¹ limit on all holdings except desert land to be reclaimed and sold, factory sites, and land held for benevolent purposes. Expropriation of land is to be completed in 5 years, and at least one-fifth of the land subject to the law is to be expropriated each year, the largest estates being the first to be broken up.

Landowners need not wait for the state to act, however. They may within 5 years, and with the approval of the Summary Court having jurisdiction,

transfer up to 100 feddans of land to their children, providing no child gets more than 50 feddans. They may also sell their land, if the Court approves, but they may sell no more than 5 feddans each to owners of not more than 10 feddans—owners who are not relatives or who are relatives beyond the fourth degree. Two rather powerful incentives for these private sales are (1) the imposition under the new law of five times the original tax on all holdings of more than 200 feddans and (2) the privilege of selling for the highest price obtainable rather than the expropriation price. The law does not require that purchasers be farmers but, since each sale must be approved by the Court, it is expected that it will approve only those sales to farmers.

When the land is expropriated, owners will be paid at the rate of 10 times the annual rent. (Annual rent is to be estimated at 7 times the tax on the land.) The price of buildings, trees, and machinery on the land will be added to its selling price.

Purchasers will pay this selling price plus a 3-percent annual interest charge. They will also pay 15 percent of the price of the land to meet the cost of expropriating and distributing it. This charge is nonrecurring. The total sum is to be paid in 30 annual installments.

The rate of compensation to owners of expropriated land is definite, uniform, and simple and easy of application. The seller receives 3 percent interest on his bonds; the purchaser pays 3 percent interest on his note. The government stands between the buyer and the seller, collecting from one and paying the other. Interest paid by the purchasers offsets interest paid to the sellers. The 15-percent charge made against the purchaser will probably cover administrative costs. Thus, the transaction is designed to be accomplished without burdening the public treasury.

Expropriated land will be distributed to peasants in units varying in size according to quality, from a minimum of 2 feddans to a maximum of 5. An exception to the 5-feddan limit is made in the case of orchards. They may be distributed in plots as large as 20 feddans. Graduates of agricultural and technical institutes will be eligible to purchase these units.

¹ A feddan equals 1.038 acres.

Recipients of land must be Egyptians without criminal records, they must be cultivators, and they must own less than 5 feddans of land. Persons actually working on the expropriated land have the first right to buy parts of it. (A laborer who knows nothing about managing a farm is not regarded as a cultivator.) Next in order of priority are the inhabitants of villages on the land who do not work on it but who support large families. The most needy inhabitants of the village are next in line of preference. Inhabitants of other villages are at the bottom of the list.

Landlord-Tenant Relationships

Even after land redistribution has been completed, many Egyptian farmers will own no land; perhaps a million peasant families now rent their farms. For that reason, the provision in the new law on landlord-tenant relationships is a significant one. It provides that only farmers who are to cultivate the land themselves can rent it, and that land is not to be leased for less than 3 years. The rental charge is not to exceed seven times the original tax on the land rented. When share cropping is practiced, the owner may not take more than one-half of the net profits after the expenses are deducted. Written contracts are recommended in the law, and, if executed, owner and tenant should each get a copy. When there is no written contract, owner and renter are to share equally in the profits after expenses have been deducted.

Thrifty, industrious tenants, receiving half the net proceeds, may be able to accumulate sufficient savings over a period of years to enable them to purchase small farms of their own.

Landless Laborers

The one-half million landless laborers employed on Egypt's farms also stand to benefit under the new law, which carries provisions that regulate their wages and sanction the organizing of unions through which farm laborers can bargain. Wages in the different agricultural districts are to be fixed every year by a committee appointed by the Minister of Agriculture. Three of the seven members of the committee will represent the agricultural worker.

Cooperatives

Cooperative associations are to figure prominently in the new agrarian structure. All peasants owning

5 feddans of land or less, whether they are purchasers of expropriated land or not, must be members of an agricultural cooperative association. Ordinarily there will be one such cooperative association for each village, but the Minister of Social Affairs can authorize exceptions and permit a cooperative to serve more than one village. He will formulate rules and regulations for the cooperative associations and name the manager of each, but one manager may supervise more than one cooperative association.

Cooperatives are to perform the following functions:

- Issue agricultural loans to members;

- Provide members with seed, fertilizer, cattle, agricultural machinery, and means of storage and transportation;

- Organize the tilling of land and see that it is used in the most efficient manner;

- Combat pests;

- Dig canals and drainages;

- Sell the main crops of members and deduct land payment installments, taxes, and agricultural and other loans from the price; and

- Give all other agricultural and social services.

When the expropriation program is completed, it may be anticipated that 95 percent of Egypt's landowners will be compulsory members of cooperative associations. Considering the functions that the cooperatives are to perform, it is doubtful if a program involving so many farm families in so vital a fashion has ever been attempted before by orderly, peaceful means in so short a space of time.

Administration of Program

Administration of the program of land expropriation and distribution is vested in a committee of 13 members, headed by the Minister of Agriculture. The Under Secretaries of Agriculture, Social Affairs, Economy, Public Works, and Finance and 7 persons appointed by the Council of Ministers are the other members. This committee is empowered to seek the help of experts and technicians. Subcommittees are also authorized. The method of forming these subcommittees, their relations to the higher committee, and their functions are to be outlined in a separate decree law.

Imprisonment and confiscation of land subject to expropriation are the penalties for violating the land reform law.

Hydroponics and Food Production

By TOM EASTWOOD

The Office of Foreign Agricultural Relations frequently receives inquiries from foreign sources about hydroponics. Many of these inquiries have been stimulated by the much-publicized use of hydroponics in Japan to produce fresh vegetables for our troops in South Korea; and not a few of them reflect misconceptions regarding the status of hydroponics today. In the interest of clearing up such misconceptions, we present the following article.

The method of growing plants without soil, called hydroponics—or tank farming, water culture, or tray agriculture—has long been a subject of much public interest. Since the middle 1930's when hydroponics was introduced as a possible means of economic culture for many plants, it has also been the subject of over-optimistic representations. Actually the semicommercial adoption of hydroponics was premature, for the amount of technical knowledge was insufficient to insure economic success. Hydroponics has been advertised as phenomenal and has often been handled improperly; as a result, it has not lived up to promises made for it.

Lack of success can be attributed to failure to follow sound technical and horticultural procedures, to high costs, and to constructional and operational difficulties. A complete lack of understanding of plants and their growth has contributed to many failures. Plants do not change their habit of growth or their responses to their environment because they have their mineral requirements spoon-fed to them. Hydroponics has been satisfactory for many vegetables (and flowers) from a yield and quality standpoint; and perishable crops such as tomatoes, cucumbers, and salad crops have been grown on a reasonably large scale. Yield and quality, however, have rarely surpassed the results of good soil culture. Hydroponics has also been satisfactory from a profit standpoint, but only under certain conditions.

Probably the major drawback to economic food production by hydroponics has been the cost of constructing the unit. It has not been possible to obtain precise cost data, but estimates based on the total cost of building an entire outdoor unit place the cost of a single bed, 100 feet long and 3 feet wide, at from \$500 to \$2,000. Thus, under practical conditions it costs between \$25,000 and \$100,000 per acre to set up a unit, figuring about 50 beds per acre.

Operational costs are high, too. Labor, for instance, is expensive. In hydroponics, like other intensive cultures such as market gardening or greenhouse culture, more labor is required than for the usual field culture, and the cost of protecting the plants against disease and insect attacks is often much greater. Some say that the cost of the chemicals used to prepare the nutrient solution governs the economic feasibility of practical hydroponics, but actually this cost is a relatively small percentage of the total operating expenses. In some cases water costs more than the chemicals.

Supervisory personnel costs are comparatively high, too, because hydroponics is a relatively precise means of crop culture and requires a knowledge of the peculiarities of the method and an elementary knowledge of chemistry. Some failures can be traced to improper use of chemical analyses methods, as well as to the use of poor methods. If the chemical results are not correct, the plants may sicken.

Past failures stress the need for careful planning and prudent operation. The operator of a financially successful hydroponics unit must have knowledge of plant growth or at least be capable of acquiring it through practical experience. The gardener's so-called green thumb rule really applies to hydroponics. The operator must also have a flexible attitude toward plant growth, for experience has shown that methods that succeeded in one area will not necessarily succeed in another. Plants vary in their reaction to different environments. The general horticultural principles of crop production hold everywhere, but the important details of operation vary greatly.

In determining the economic feasibility of establishing a hydroponics unit for food production (and for floral crops) several financial factors must be considered. The primary question is how much can the operator spend to grow the fresh produce and still make a profit. The particular needs of a given area and the supplies available govern this answer. If supplies grown in soil are available

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nearby, production costs per unit of produce grown by hydroponics must match local soil culture costs. Under such circumstances, they usually do not. Where local supplies of fresh produce are not readily available or are very expensive, hydroponics has a possible economic place in food production. Such areas, for example, barren oceanic islands, large mainland areas of an arid nature, or other areas in which the acreage of adequate agricultural soils is very limited, must be able to produce "fresh food" by hydroponics at the same cost as "near fresh produce" shipped in from distant points. Hydroponics might also be suitable in densely populated areas whose hinterland cannot supply sufficient food.

The economic success of hydroponics culture also depends to a great extent on the choice of vegetable crops (or floral crops). At present it is practical to grow only perishable vegetables and ones that sell for a high unit price. Tomatoes and cucumbers, for example, are more profitable than lettuce. The

growing of carrots, onions, or other vegetables that store and ship well is not feasible.

Certain horticultural and technical considerations also affect the economic success of food production by hydroponics. The first is a technical consideration—the selection of the type of unit to be constructed. There are three general types to consider. One is for fluid culture, commonly known as water culture. This method of hydroponics has had somewhat limited large-scale application because of technical difficulties in the litter-type root-supporting system. Also, technical control of the nutrient solution and proper control of the oxygen level in the root medium, both litter and fluid phases, are more difficult in this type of culture.

The easiest and cheapest type of unit to construct and the easiest to operate is that for surface irrigation, or sand culture. However, this method permits less precise control of the water and the nutrient ion levels in the root medium; unmodified sand culture requires no water-tight beds, and water and



Growing lettuce by hydroponics. Perishable crops like lettuce, and tomatoes and cucumbers, can be produced profitably by hydroponics if adequate supplies grown in soil are not available nearby and if prices for fresh produce are high.



Section of a plant bed used in the gravel culture method of hydroponics. This method has been the most widely used by commercial growers.

mineral salt supplies are therefore handled in much the same manner as in usual soil culture.

To date the most adaptable form of hydroponics for commercial use has been the subirrigation, or gravel culture, method. The unit for this method is quite expensive to construct, but operating costs appear to be lower than those for the other methods, and it has several other advantages. This method permits more precise control of the water and the mineral ion needs of the crop than sand culture. One of its greatest advantages over the water culture method is the simplicity of supporting the roots of the plant. In addition, the nutrient ion levels and the oxygen concentration in the root medium can be controlled more easily than in water culture.

In the gravel culture method the nutrient solution can be conveyed from the storage reservoir to the plant beds in one of two ways—through pipes and through flumes. Piping is quite suitable for small units, but the most practical design for large-scale units is the flume system developed by C. L. Klotzbach in Florida. In the flume system, open concrete trenches are used to carry the nutrient solution to and from the plant beds during the

irrigation operation. Flume design units are much cheaper to construct and to operate than pipe units.

Hydroponics lends itself to the use of reasonably precise means of technical control in many of its plant-growing operations. However, since plants are extremely variable organisms, controls must be sufficiently flexible to meet varying conditions.

Control over the mineral ion concentrations of the nutrient solution is both practical and necessary. It is not necessary to attempt to maintain very-narrow ranges of the major, or macro, nutrient ions. Plants will produce satisfactory crops when supplied with a relatively wide range of the essential macro nutrient ions. A lower and upper limit is recommended for the level of the nitrate, potassium, phosphate, calcium, magnesium, and the sulfate ions in the nutrient solution. Usually a range of 40 to 50 percent below and above the normal level of a "fresh solution" will suffice. Furthermore, some of the laboratory methods in use are not sufficiently accurate to maintain control to very narrow limits.

To date the most practical way to handle the supply of the minor, or micro, nutrient ions in the nutrient solution has been on a fixed schedule developed over a period of years by plant nutrition laboratories. Chemical analyses methods in general use have been found to be less accurate indicators than the plants themselves. The schedule established by the laboratories calls for a definite concentration and application of iron, manganese, boron, copper, and zinc and practical work has not dictated a need for other micro elements.

The quality requirements for the water to be used in hydroponics units have often been over-emphasized, but any potable water is suitable. However, the water used may make it advisable to alter the nutrient solution formulation. In some areas sufficient micro elements are available in the water to permit alterations in the standard recommendations. When hard water is used, the quantity of calcium and magnesium salts in the nutrient solution formulation can be reduced considerably. Sometimes the presence of relatively high levels of sulfate and chloride ions in the water necessitates frequent partial or complete changes of the nutrient solution.

Proper control of the total volume of the nutrient solution is necessary. Generally a fluctuation of 10 percent below and above the "normal volume" of a "fresh solution" is permissible.

The how, when, and why of nutrient solution changes is another technical control matter. When suitable analyses methods are properly used, and

plant growth is satisfactory, the nutrient solution need not be changed. It is advisable to change it, however, after growing long-term crops like tomatoes and cucumbers.

Another major technical control problem is the maintenance of the proper range of the pH of the nutrient solution. This is often handled improperly in practical units. Many crops will grow satisfactorily within the pH limits of 5.0 to 6.8, but most crops will grow best in a pH range of 6.0 to 6.5. It is advisable to maintain a relatively narrow pH range, preferably no more than 0.5 or 0.6, in order to reduce excessive precipitation of phosphate salts of micro elements such as iron and manganese. The use of such salts as ammonium sulfate for controlling the pH of the nutrient solution is not workable in practical units. In fact their use at times causes trouble because too much of the ammonium ion is added, especially in the Tropics. Sufficient phosphate ion in the nutrient solution will buffer the solution to maintain a suitable pH range. This buffering can be done without adding too much of the phosphate ion to the nutrient solution. Elimination of violent fluctuations, especially above pH 6.8, reduces excessive precipitations of the ions mentioned above. However, to make this procedure operational it requires correct control of the pH of the make-up water, which is added to maintain the proper solution volume. The pH of the make-up water must be adjusted to the same range as the nutrient solution either before the water is added, or at the time it is being added to the nutrient solution. (When nutrient solutions are formulated with the correct level of the phosphate ion it is rarely necessary to acidify or alkalize a freshly prepared nutrient solution. Sufficient phosphate will be present to stabilize the pH at the correct level, usually between 5.9 and 6.6.)

Technical control is also important in irrigation practices. The several requirements discussed below apply in principle to all three major types of hydroponics, but, since the gravel culture method is the most popular one commercially, the following discussion will pertain to it directly. The purpose of the irrigation operation is first, of course, to supply water and second to supply the necessary mineral ions to the root medium.

Contrary to popular opinion, the rate of irrigation is very important. Rapid rates of filling and draining the plant beds are required to support good plant growth and production, which are achieved by supplying the proper balance of moisture and oxygen

in the root medium. Several cases of economic failure of practical hydroponics have been traced directly to too slow an irrigation rate. The best knowledge to date supports the recommendation of a rate of 15 minutes for filling and 15 minutes for draining the hydroponics beds, regardless of size. However, more research is required on this point.

The height of the nutrient solution in the root medium during the irrigation operation should be adjusted in accordance with growing conditions and the kind of crop grown. The recommended procedure is to raise the irrigation level as high as possible while keeping the surface of the root medium dry. This is chiefly for the purpose of disease control. For crops such as radishes the irrigation level should be steadily dropped as the crops develop.

No fixed rule is possible for regulating the frequency of the irrigation. The basic limiting factors are the water requirements of the plant and the oxygen requirements of the plant roots. Under most circumstances a frequency of one to three times a day is ample, depending on plant and weather conditions. Too much water or too frequent irrigation is often more harmful than not enough water or too little irrigation. In other words, irrigate often enough to make the plants grow and yield well. The time-honored method used in soil culture of regulating moisture (where possible) to alter plant growth is quite adaptable to hydroponics. Manipulating the frequency of irrigation is the most practical and suitable way of controlling the succulence of the plants.

Regardless of the care given technical considerations—choice of location, crop, and type of unit—hydroponics cannot succeed unless standard horticultural practices are followed. The various operations of planting, growing, and harvesting are essentially the same in hydroponics and soil culture. Both crops are affected by weather. Both must be protected from insects and diseases. Hydroponics culture, however, requires greater care in the application of insecticides and fungicides to eliminate the build-up of toxic residues in the root medium. Hydroponics crops are also attacked by soil-borne fungus diseases and nematodes, and sterilization of the root medium is needed often. Even such pests as ants, mice, rats, lizards, and birds damage the crops. Thus, it can be seen readily that hydroponics is just another method of plant culture; *the plant is "boss," not the culture method*. It is only with such an understanding that hydroponics can be put to good use as a means of food production for mankind.

Agricultural Statistics In Soviet Russia*

by LAZAR VOLIN



Whenever the Soviet Union publishes figures on crops and livestock numbers, as it has not often done since the war, the question arises "How reliable and usable are such estimates?" This article seeks the answer to the question by exploring the methods used in collecting and presenting agricultural data.

Agriculture has always held a prominent place in Russian statistics principally for two reasons.

First is the vital importance of the harvest to the well-being of the Russian people, predominantly a rural folk, as well as to the economic programs of both the Tsarist and Soviet Governments. Crop failures were frequent, and concern over the size of the harvest was responsible, almost 70 years ago, for the development of the system of Russian crop statistics.

The second reason for agricultural statistics' being much to the fore is the crucial historic role of the agrarian, or peasant, problem, which gave impetus to comprehensive statistical rural surveys covering numerous phases of rural sociology and farm economics.⁽¹⁾ Such surveys were conducted by the Russian zemstvo, or local representative bodies, created in the 1860's which, as a rule, were more progressive than the central government in St. Petersburg. These surveys, despite some shortcomings, were valuable both because of the richness of statistical material collected and because of the pioneer methods used.⁽²⁾

Though suspected by the Tsarist Government, zemstvo statistics were the pride of progressive Russia. They were also praised by Lenin with reservations and the traditions of these statistics were still tolerated during the early Soviet period, although the zemstvo itself had ceased to exist. During the period of the relatively liberal New Economic Policy, or NEP, in the 1920's some of the former

zemstvo statisticians even held high posts in Soviet statistical and planning agencies. But with the Stalinist attack on, and purges of, Russian statistics in the 1930's, all this changed. Some of the techniques, no doubt, are still being employed where it suits the Kremlin's purposes. But the spirit of objectivity and independence and the high ideals of public service of Russian statisticians have been subordinated, as everything else in Soviet cultural life, to the current Party Line and propaganda.

In general, since collectivization of Russian agriculture, in the 1930's, more statistical data have been collected by the government on various phases of agriculture than ever before. However, significant agricultural information was becoming scarce even before World War II, especially compared with that available in the 1920's. It is true that in the 1930's a number of statistical publications dealing with agriculture appeared,⁽³⁾ but even in detailed publications certain important subjects were taboo, particularly price data and consumption statistics, which were published in some detail during the preceding decade. The valuable food budget surveys, which were conducted in the 1920's, were apparently discontinued in the 30's. Since the war, little has been published. Such statistical data as do appear in Soviet periodicals and the daily press are, for the most part, fragmentary, discontinuous, not easily comparable, often stated in percentages of an unknown base, irregularly published, and lacking in essential regional detail. Figures are lumped together without a break-down into essential components. For instance, a figure for the total grain and legume crop is given, but none for rye, barley, oats, etc. No statistical data on foreign trade, in which agricultural products play an important part, have been published since 1938.

Nevertheless, statistics are energetically collected by the Soviet Government. It realizes that thorough control and planning of agricultural production, in which the government has a big financial stake, can-

* Based on a paper read at the Annual Meeting of the American Statistical Association in Chicago, Ill., Dec. 29, 1952.

¹ See page 61 for literature cited.

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not be accomplished without adequate statistical data. Since goals are established in the comprehensive annual plans, Soviet administrators must gage the extent to which such targets are fulfilled, especially since a system of rewards to farm workers and managers is also linked to the fulfillment of some planned goals.

Reciprocally, the close government control of agriculture and its organization in large units requiring a comprehensive accounting system facilitate the collection of a great variety of statistical data.

Reliability of Statistics

The quality of the figures—their reliability—is often inferior to their quantity, however. This qualitative inferiority is due, in some cases, to the poor training and overburdening of the bookkeeping, statistical, and administrative personnel who are charged with gathering primary statistics. But an even more important reason for the doubtful reliability of statistics in many cases is the stern necessity to fulfill government plans. It may be extremely difficult, or unprofitable or impossible, to execute a certain plan. But failure to do so may lead to dire consequences, while success is likely to be rewarded. In order to comply with government orders, Soviet citizens have developed methods by which “statistical” fulfillment of plans is achieved. Such methods range from extremely perfunctory and defective work to sheer falsification. All this is embraced by a euphemism, *ochkovtiralel'stvo*, which covers a multitude of subterfuges and may best be translated as “to throw dust in the eyes.” The wide spatial distribution of the production process in agriculture, and especially in Russian agriculture, compared with the manufacturing industry, facilitates *ochkovtiralel'stvo*. Farmers’ antagonism to Soviet control and exactions is also an important contributory factor. Sometimes *ochkovtiralel'stvo* is detected by the superior authorities; sometimes it is not. In the “detective” work that this situation demands, statisticians are supposed to play a prominent role, according to authoritative spokesmen. (4)

Another difficulty that bedevils historical comparisons of Soviet agricultural statistics is the instability of the reporting territorial unit. The continuous shifting in the boundaries of administrative divisions, for which statistics are reported, greatly complicates regional analysis, so essential in a large, diverse country like the Soviet Union. Too, changes in the national boundaries of the USSR, resulting

from the two world wars, are not always accurately reflected in Soviet agricultural statistics and some times are unscrupulously or carelessly used in making comparisons.

Collection Methods and Type of Data Gathered

To turn now to the type of data collected but often unpublished. The figures cover such traditional subjects as farm land use, the sown area, crop yields and production, livestock numbers, and production of animal products. Statistics are also collected on the distribution of the collective farm output, farm income and capital investment, deliveries to the state of farm products, draft power and machinery, and especially a wide range of farm operations and practices. The latter reflect the interest of the Soviet Government in improved farm methods, or, in Soviet parlance, the so-called agro-technique. For instance, figures are recorded on such diverse operations as the preparation of the summer fallow, shallow plowing after the harvest, fall plowing for next spring's seeding, weeding of the fields, cultivation of crops, and mating of farm animals. But probably the field in which the Soviet Government has the most extensive statistical information is that of compulsory deliveries and disposition of farm products. This information was published in great detail in the 1920's, much less extensively in the 30's, and in mere dribblets since the war.(5)

Much information is also collected on farm labor: on the number of different types of workers, such as tractor drivers and combine operators; on the managerial and technical personnel; on their earnings, etc. A great deal of detailed statistical data are gathered, not only for collective and state farms but also for the state-owned machine-tractor stations.

Mechanization has assumed great practical importance since the collectivization of agriculture. Special attention, therefore, has been paid to statistics on the number and power capacity of tractors, on combines and other machinery, and on their operations and maintenance, including the very important fuel expenditures. During the postwar period, the tendency has been to publish statistics in terms of power capacity rather than of the more meaningful actual number of tractors. A danger signal is needed here: the figures on total tractors in the USSR, however expressed, may include a sizable proportion of units that are actually unfit for operation, because of excessive wear and tear on the machines.

Data have been collected for many years on the budgets of peasant farmers and, subsequently, of collective farm members. This work was largely interrupted during the war but has been resumed since then. (6) Relatively little of this material was published in a systematic form even before the war, and none has appeared since.

Each collective and state farm and machine-tractor station servicing collective farms is required to submit, in accordance with a prescribed procedure, comprehensive annual reports on its technical and financial operations, as well as a number of special reports to the local government agricultural agencies and the regional inspectors of the Central Statistical Administration of the USSR. The latter has the over-all responsibility for collecting and analyzing Soviet statistics. The various agencies concerned have both the power and the duty to verify the data by spot check, sample surveys, and inspection of various documentary data and records of the farms and machine-tractor stations.

Thus, a report is required from each collective farm on the measures taken to prepare for the sowing campaign, which include assembling of a seed supply of proper quality and various field operations. Then, every 5 days during the seeding season,

a report must be submitted by each collective farm on the acreage seeded, based on the performance records of the section heads, so-called brigadiers. At the end of the sowing season another report gives the total sowings by individual crops; these acreage figures must be carefully verified by the collective farm management. It should be noted that the final Soviet crop acreage figures published are those at the end of the spring sowing campaign; they exclude the damaged or winter-killed area under fall-sown crops that was not resown in the spring. But in these acreage figures, any damaged or abandoned area after the spring-sowing campaign is not deducted as it is in the United States statistics of acreage harvested.

For figures of livestock numbers, which dropped sharply during the agricultural collectivization and, following a subsequent recovery, again during the Second World War, reliance is placed on annual censuses taken at the beginning of the year, supplemented by special comprehensive monthly reports from collective and state farms, as well as by their general annual reports and by special investigations and check-ups of the Central Statistical Administration. In addition, what amounts to a census of privately owned livestock, both in the rural and urban areas, is taken each June on an increasingly more

(1) "Progress of Agricultural Statistics in the World," by E. S. and W. S. Woytinsky, *Journal of Farm Economics*, v. XXI, No. 4, p. 778, November 1939.

(2) "The History and Development of the Official Russian Statistics," by A. Kaufmann, in *The History of Statistics, Their Development and Progress in Many Countries*, collected and edited by John Koren, p. 531, The Macmillan Company, 1918, New York.

(3) "A Survey of Soviet Russian Agriculture," by Lazar Volin, U.S. Department of Agriculture Monograph 5, 1951. (This publication contains a bibliography in which are listed several references on Soviet statistics.)

(4) "Some Questions of Verification of Departmental Accounts and Reports," by S. Kunin, *Vestnik Statistiki*, No. 5, p. 57, 1951, Moscow.

(5) "The Accounting of Procurements of Agricultural Products," by G. Petrov, *Vestnik Statistiki*, No. 5, pp. 45-50, 1950, Moscow.

(6) "A New Stage in the Develop-

ment of the Statistics of Budgets of Workers, Employees and Collective Farmers," by S. Postnikov, *Vestnik Statistiki*, No. 6, p. 20, 1951, Moscow.

(7) "A Decided Improvement in Livestock Statistical Work," *Vestnik Statistiki*, No. 6, pp. 11-17; also 82-88, 1951, Moscow.

(8) "Sotsialisticheskoe Sel'skoe Khoz-yaistvo SSSR," *Statisticheskii Sbornik*, *Tsentral'noe Upravlenie Narodnokhoz-yaistvennogo Ucheta Gosplana SSSR*, 1939, Moscow.

(9) "Slovar'-Spravochnik Po Sotsial'-no-Ekonomicheskoi Statistike [Dictionary-Reference Book on Social-Economic Statistics], *Tsentral'noe Statisticheskoe Upravlenie Gosplana SSSR Otdel Uchebnykh Zavedenii*, p. 201, 1948, Moscow.

(10) "Sbornik Rukovodyashchikh Materialov Po Kolkhoznomu Stroitel'stvu [Collection of Guiding Material on the Organization of Collective Farms], p. 187, 1948, Moscow.

"Kurs Sel'Skokhoz'yaistvennoi Statis-

tiki [A Course of Agricultural Statistics]," by S. V. Shol'ts, p. 37, 1945, Moscow.

(11) *Izvestiya*, Apr. 17, 1951, Moscow, carried the official report on the fulfillment of the fourth 5-year plan, 1946-50, which stated: "A serious fault in the production of field crops is still the existence of large losses in harvesting crops, especially of grain, flax for fiber, and sugar beets."

(12) "Sobranie Postanovlenii SSSR [Collection of Decrees of the USSR]," No. 45, p. 670, Art. 357, 1939, Moscow.

(13) "Soviet Agricultural Collectivism in Peace and War," by Lazar Volin, *American Economic Review*, XLI, No. 2, pp. 465-474, May 1951. (Papers and Proceedings.)

"The Turn of the Screw in Soviet Agriculture," by Lazar Volin, *Foreign Affairs*, v. 30, No. 2, pp. 277-288, January 1952.

(14) Cf. "The Socialized Agriculture of the USSR," by Naum Jasny, 1949, Stanford, Calif., pp. 659 and 728.

comprehensive scale. The annual censuses, especially the general censuses taken at the beginning of each year by disinterested personnel, should yield fairly reliable results, though there may be misgivings about this or that figure. It is a fact that the losses suffered during collectivization and the Second World War were reflected in the statistics when they were published. There has been, however, considerable dissatisfaction with the monthly livestock reports of the collective farms, which were criticized by authoritative Soviet sources for underreporting and distortion.⁽⁷⁾

A favorite trick resorted to by Soviet sources in dealing with livestock figures was to publish, usually in the form of percentages, the increases in collective (communal) livestock only. Such percentage increases are usually very impressive, but they do not reckon with livestock owned privately by members of collective farms, which, for many years in the past, exceeded the collectively owned herds. Privately owned livestock in such a situation not only may not increase but actually is likely to decrease, because of government pressure against private ownership. Thus, the impressive increase in collective livestock may be largely offset by a decrease in the privately owned livestock, some of which may actually be transferred to the collective herds. As a result total livestock numbers (collective plus privately owned) may undergo little or no increase, or even a decrease. However, as collective livestock is becoming increasingly important in Soviet animal husbandry in the 1950's, such discrepancy between reported collective and total livestock figures will diminish.

Much less is available on the output of animal products than on livestock numbers. Most published statistics on animal products—on butter or meat products, for instance—have been data on production of the large-scale state-controlled industry and not on the total output. When total meat production figures are published, however, as for instance for 1938,⁽⁸⁾ meat is combined with slaughter fats.

Biological Crop Yields—A Special Problem

I come now to the crucial question—that of crop yields per unit of land (per hectare)²—and, consequently, the production figures of different crops, which constitute the basic data of Russian agricultural statistics. Production figures, as is well-known, are obtained by multiplying the yields by the acre-

age, or hectareage. So important is this task considered that, in addition to the staff of the Central Statistical Administration and the regional agricultural departments and machine-tractor stations, which all deal with crop figures, a special organ was created to carry it out—the Office of the Chief Inspector for the Estimating of Crop Yields, attached to the Council of Ministers of the USSR. It has a staff of local agents, so-called Inter-Regional Inspectors.

The managers of collective and state farms are responsible for reporting crop figures in the first instance. These figures must be checked by the agronomic personnel of the regional agricultural departments or machine-tractor stations. While these agencies are responsible for the crop figures within their territory, the final authority for determining crop yields and production is vested in the Office of the Chief Inspector for the Estimating of Crop Yields. A variety of information, including weather data, records of experiment stations and of state seed test plots, as well as findings gained by personal inspection, are used to check the farm reports on yields.

Another prescribed verification method for which inspectors of the Central Statistical Administration are responsible is that of a pre-harvest sample survey in each region. In such tests, the crop is supposed to be carefully harvested and measured prior to the general harvest on a number of small plots selected in line with the established statistical procedure. How well the latter is adhered to in practice, it is difficult to say. On the basis of such surveys and all other information, yield figures are determined by the Office of the Chief Inspector for Estimating Crop Yields, which has final authority. The decisions of this government agency cannot be appealed or even "normally" criticized.

Now, the essential point to grasp about Soviet crop yields and production statistics is that, in the 1930's, a radical change was made in the character of the published figures, which led to the overreporting of the crops. Because crop statistics during the Soviet period have always been linked with the fiscal interest of the state, there has been a tendency on the part of the peasant farmers, according to Soviet sources, to underreport crops. This propensity to under-estimation would naturally have continued under collective farming when government exactions increased. The Soviet Government, however, was not content with checking underreporting but developed a system of its own—that of overreporting.

²A hectare equals 2.471 acres.

Data for yields and, consequently, for production are exclusively preharvest estimates of the crops standing in the field, and not the crop in the barn or the bin, which is the accepted crop estimating procedure the world over, even in Soviet Russia at one time. This is how an official Soviet publication defines crop yields: "The actual yield of crops per hectare, at the time of maturity, estimated before the beginning of a timely harvest of such crops." (9) Since 1942, even the use of threshing data in estimating crop yields has been prohibited, because they "underreport the actual yields." (10) But the Soviet published figures—the figures of what is sometimes called a biological crop—do not take into account the large harvesting losses of 10 to 20 percent or more, that are common in the collectivized agriculture of the Soviet Union. These losses have been officially investigated, acknowledged, and lamented time and again. (11) Yet, they are the very reason for introducing the new biological method of estimating yields. In fact, an official instruction issued on July 21, 1939, for estimating a number of non-grain crops, such as cotton, flax, sunflowers, sugar beets, and potatoes, prescribed that "actual yields per hectare" must include unharvested crops left in the field and also lost during the moving of the crop. (12)

It is necessary, however, to go further. Biological crop estimating methods not only deliberately conceal large crop losses but, in general, lend themselves to overestimating production and the quantities of various crops available for domestic consumption, stockpiling, or export. This practice has been accentuated since the war, with the huge grain and cotton figures reported during the years 1948-52. These preharvest estimates are not corrected by harvesting results, let alone by the analysis of postharvest utilization, as preharvest forecasts normally are everywhere, including even Soviet Russia at one time. Doubtless, under such conditions, the temptation, and probably the political pressure, is strong to overestimate crops. The stern warning of the official crop estimating regulations against underreporting of the crop by managers of collective farms, coupled with frequent sharp accusations in the Soviet press of such "anti-state" practices and purges of Soviet statisticians, indicate very clearly to experienced Soviet bureaucrats "which way the official wind blows." By the same token, for the Kremlin these exaggerated crop figures are so much grist for the mill. Such figures help to demonstrate the reputedly superior productivity of collectivized agriculture over indi-

vidual farming and to justify the ruthless destruction of the latter. (13) They help to advertise large export capabilities and to buttress unreasonable Soviet claims in international economic negotiations, such as those on the International Wheat Agreement of 1949. Hence, the inflated crop figures are a convenient instrument of internal and external propaganda. Even more important is the fiscal significance of inflated crop figures as a justification of the government's heavy extraction of farm products in various forms, of compulsory collections from the peasants. Finally, the employment of the swollen crop figures in various production indices and estimates of national income helps to inflate the latter, an inflation that is also highly palatable to the Kremlin. (14)

While presenting a misleading statistical façade to the public, the Soviet Government, itself, is by no means in the dark regarding agricultural production and the food supply. Although the Soviet Government publishes exaggerated biological crop estimates, it doubtless has for policy-making purposes figures of the actual barn outturn of crops, derived from the carefully gathered threshing data for grain, ginning of cotton, and similar sources; these figures are subject, of course, to what I said earlier regarding *ochkoviralel'stvo*, the unknown margin of error due to possible distortion of statistics by the lower government echelons. But such information, and the very fact that a double set of crop figures exists, are kept in strict secrecy. Actually, the published Soviet crop figures since the 1930's have not been comparable with those for the previous years or with the crop figures of the United States and other countries. Still such comparisons, obviously for propagandistic purposes, are commonly made in Soviet publications without qualification. Naturally, the nonspecialists in the field of Russian agricultural and economic statistics are not, as a rule, aware of this fact.

Now, does the Soviet use of biased biological preharvest crop figures constitute a statistical falsification? Would "counterfeiting," which the dictionary defines as "an imitation of something genuine made with intent to deceive," be a more appropriate term? Or, since the Soviets themselves revealed the estimating procedure, should it be more charitably characterized by some polite euphemism? I shall let my readers judge for themselves such semantic differences. But I certainly cannot warn too strongly, as I have been doing for the last 20 years, against unqualified acceptance of Soviet crop statistics.



U.S. DEPARTMENT OF AGRICULTURE

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Two U.S. Department of Agriculture scientists—Dr. F. L. Wellman and Dr. W. H. Cowgill—circled the globe last year in search of coffee varieties that are resistant to Hemileia rust. Thus rust destroyed most of the Arabica coffee plantations of the East half a century ago and has since been an ever-increasing threat to the source of coffee for the United States—the plantations of Latin America.

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